Abrasives – particle size and shape analysis of abrasive grains with Dynamic Image Analysis

Instrument: CAMSIZER X2

Introduction

Abrasives are grains of resistant materials which are used to work on material surfaces. These grains are usually incorporated in grinding tools, either on the surface of some type of carrier (e. g. paper) or in ceramic bonded abrasive bodies (e. g. cut-off wheels). The particle size of these grains ranges from a few micrometers to millimeters. The abrasive grains are classified as micro grit (approx. < 50 µm) and macro grit (approx. > 50 microns).

Abrasive materials include silicon carbide, corundum, boron carbide, cubic boron nitride (CBN), quartz, garnet, several other ceramic materials and, of course, diamond. Some of these materials occur in nature, but most of them are industrially produced today. After chemical synthesis, the abrasive grains are further processed by size reduction and screening with the objective of obtaining very narrow size distributions. This guarantees that the grinding tools produce a uniform abrasion of the surface without leaving scratches or other damages. International standards such as FEPA (Europe), ANSI (USA), JIS (Japan) describe the standardized grain size classifications used in the industry. The standards also specify the particle size analysis procedures such as sieve analysis and sedimentation.

silicon carbide grains

semi-friable grains

Surface-bonded abrasives

Ceramic-bonded abrasives in grinding bodies

***Fig. 1**: Examples of abrasive grains and grinding tools*

Quality control requirements

The international standards on abrasives include a description of the traditional analysis methods for particle size determination. The method specified for macro grits is sieve analysis, for micro grits it is sedimentation analysis and impedance measurement (Coulter Counter).

The purpose of particle size analysis is to ascertain whether the size distribution matches the relevant specifications. An important parameter is the detection of oversized grains, which would make the abrasive unusable. Particle shape analysis also plays an important role in the quality control of abrasives. Particle geometry can vary from blocky and cubic to spiky or flattened. The international standards hardly mention any analytical techniques for the determination of the particle shape.

The CAMSIZER X2, based on dynamic image analysis, easily replaces all traditional methods and additionally provides information on particle shape. The time of analysis is only 2-3 minutes which leads to higher sample throughput and more thorough quality control. Thanks to the modular design of the CAMSIZER X2, both macro and micro grits can be characterized. The instrument can be equipped with the X-Fall (dry measurement of coarse grains and pourable materials) or X-Jet module (air-jet dispersion for fine, agglomerated material) or with the X-Flow module for wet analysis of very fine micro grits.

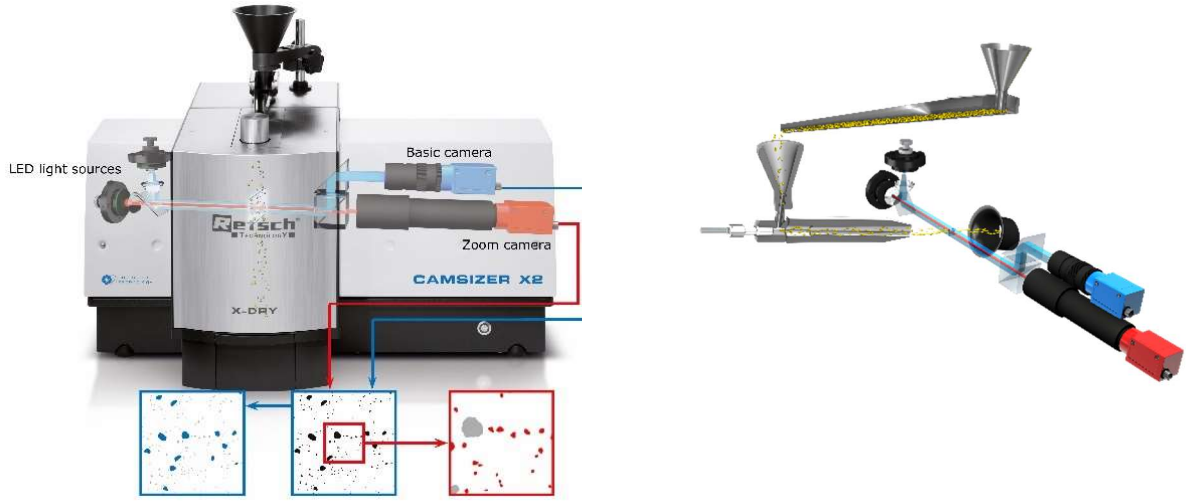

Fig. 2: *Left: CAMSIZER X2 instrument design and measurement principle (dynamic image analysis with dual camera technology). Right: Dry dispersion module X-Jet*

Example 1: analysis of micro grits with air-pressure dispersion

Five samples of P320 micro grit of corundum from five different manufacturers have been analysed with the CAMSIZER X2 using dry dispersion with the X-Jet module. The dispersion pressure was 50 kPa. The specification of these grits according to FEPA should be d50 = 46.2 µm +/- 1.5µm, d97 < 63.8 µm; d5 > 34.2 µm, and no particles > 94 µm.

The CAMSIZER X2 results show that at least one of the five samples is out of specification. The CAMSIZER X2 measurements also show differences in particle shape. Regarding the aspect ratio (width divided by length) the sample from manufacturer 4 has the most elongated particles compared to the other samples.

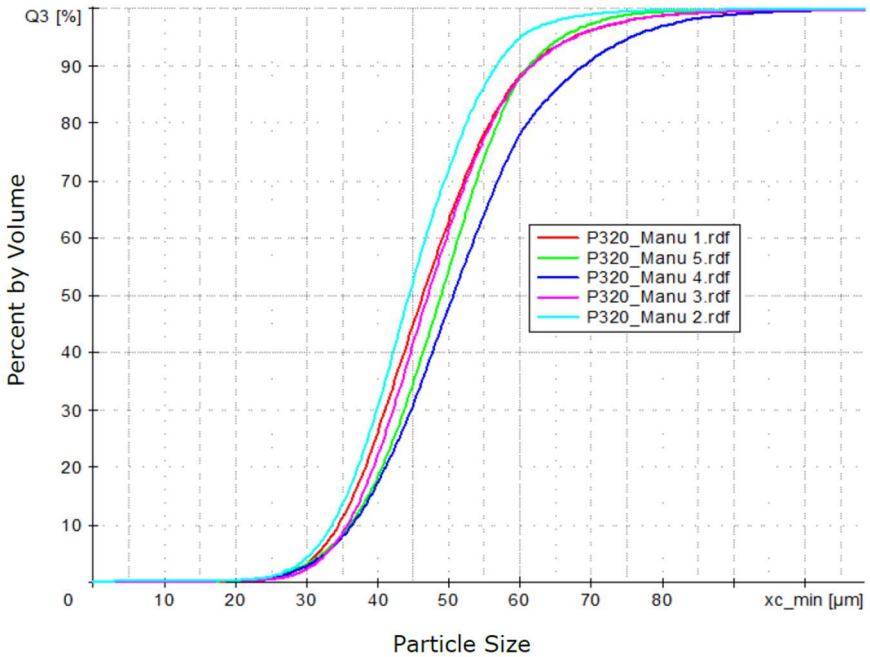

Fig. 3: *CAMSIZER X2 size measurement results of five P320 corundum samples. The result is displayed as a volume based cumulative distribution Q3. The samples have been obtained from five different manufacturers (Manu 1-5)*

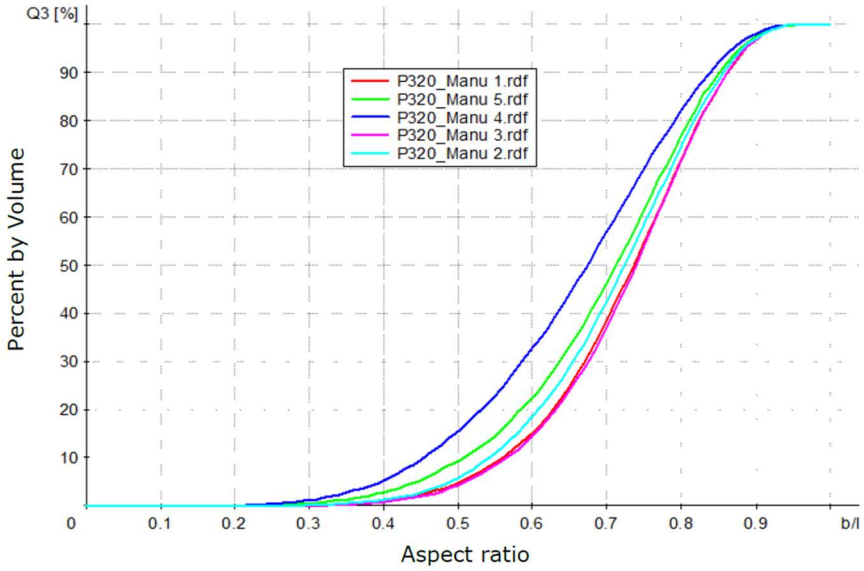

Fig. 4: *CAMSIZER X2 shape measurement results of five P320 corundum samples. The distribution of the aspect ratio is displayed as a volume based cumulative distribution (Q3). Samples with more elongated particles will plot on the left side of the diagram. The material from manufacturer 4 (**blue curve**) is more elongated than the other samples.*

Example 2: analysis of macro-grits and comparison with sieve analysis

Example 2 shows the CAMSIZER X2 analysis of a NK16 corundum macro grit using the X-Fall module. With the X-Fall option the particles pass the measurement zone in free fall. The red curve represents the CAMSIZER X2 result and the black asterisks represent the data points of the sieve analysis. A material related correlation algorithm guarantees a best possible match between image analysis and sieve results. Product specifications can therefore remain unchanged.

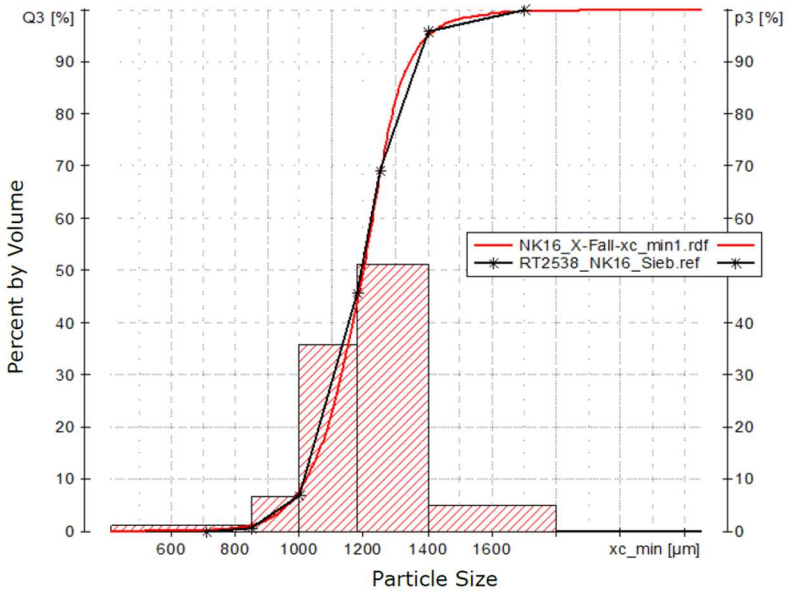

Fig. 5: *CAMSIZER X2 measurement results NK16 corundum macro grit (**red curve**). The corresponding result of sieve analysis is displayed as **black asterisks**.*

Example 3: detection efficiency for oversize grains

Example 3 illustrates the high detection sensitivity of the CAMSIZER X2 for smallest amounts of oversized grains. A P60 master grit sample was analyzed with the CAMSIZER X2 using the X-Jet module and 20 kPa dispersion pressure (red curve). Note the good agreement with sieve analysis (black asterisks)! In a second step, 0,3 % of oversize (particles >355 µm) was added to the P60 sample and analyzed with the CAMSIZER X2. The 0,3 % are accurately determined by the instrument (green curve).

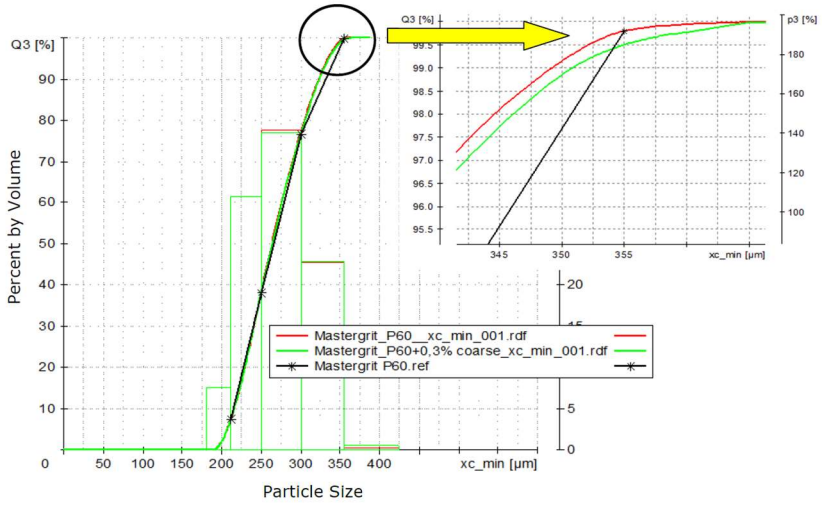

Fig. 6: *CAMSIZER X2 measurement results of Mastergrit P60 (**red curve**) and the corresponding sieve result (**black asterisks**). 0.3 % of oversize has been added which is accurately detected by the CAMSIZER X2 (**green curve**).*

Summary

The CAMSIZER X2 is perfectly suitable for the routine analysis of abrasives grains. Thanks to the modular design, macro grits and micro grits can be measured at optimum conditions. The CAMSIZER X2 is able to replace traditional sieve analysis because identical results can be achieved. Users benfit from reduced workload, higher sample throughput and a high level of automation. The results are objective and user independent. Thus, the CAMSIZER is ideal for quality control purposes. If only macro grits or even coarser material is to be analysed, the CAMSIZER P4 is available as an alternative device. CAMSIZER P4 measures pourable bulk materials in free fall and covers a size range up to 30 mm.

CAMSIZER P4 - Benefits at a glance

- Flexible dispersion options (air-pressure, liquid, free-fall) makt the instrument capable to measure micro as well as macro grits
- Unique, almost 100% agreement with the results from sieve analyis according to FEPA and other standards
- Very high sensitivity to oversize particles
- High sample throughput: only 2-3 minutes per measurement
- Very repeatable results with excellent instrument to instrument agreement
- Shape analysis of abrasives is possible: roundness, circularity, aspect ratio, etc.
- Automated analysis
- Results comparable to sieve analysis
- Objective, independent of operator
- Low maintenance, robust design

For further information please contact us at:

www.microtrac.com